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ABSTRACT

Mathematics as a curriculum area might be taught from the point of view of several philosophies of education. This paper discusses philosophical considerations in teaching mathematics such as the philosophy of experimentalism, philosophy of decision making, and measurement driven philosophy. It is concluded that the philosophy or philosophies chosen in instruction should harmonize with pupils' individual learning styles. (ASK)

PHILOSOPHICAL CONSIDERATIONS IN TEACHING MATHEMATICS

Dr. Marlow Ediger

Mathematics as a curriculum area might be taught from the point of view of several philosophies of education. One philosophy is that it is a body of subject matter to be learned. Thus, mathematics has a subject matter component only. There are teachers who teach mathematics as if it contains a scope and sequence of subject matter to be learned by pupils. Thus, mathematics is taught as a separate subject area with little or no relationship to other curriculum areas. Mathematics may also be taught as content in and of itself with little or no relationship to the outside world of being practical. The subject matter is then worthwhile for its own sake. Order and structure are inherent. This can be readily observed when writing the counting numbers horizontally as follows:

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50

The pattern is just as obvious when reading the counting numerals vertically. There are interesting patterns when observing the numerals in terms of the commutative property of addition in that A+B= B+A, or in multiplication in that AXB=BXA. Learning these properties is important for young pupils as well as for graduate students in mathematics. Thus, 4+5=5+4 learned meaningfully is helpful in later learning that 98,654 + 45,689= 45,689+98,654. Any other values listed in addition, no matter how large may be added using the commutative property of addition. The same would hold true of multiplication in that 2X3= 3X2 or 12345 X 54321= 54321X12345. The associate property of addition in that A+B+C =C+B+A or in multiplication in that AXBXC=CXBXA emphasizes additional order in mathematics. The associative property too states that there can be any number of addends arranged in any order in addition, or factors in multiplication arranged in any order and the sum for addition, as well as the product in multiplication would be the same.

Subject matter objectives receive the most emphasis in teaching and learning, in a subject centered curriculum. These objectives might be further classified in terms of being facts, concepts, and generalizations. The basic facts of addition, subtraction, multiplication, and division need to be mastered in a meaningful way. Concepts chosen for teaching subject matter need to be relevant and worthy of inclusion. Concepts such as radius, squared, pi, circumference, as examples, should be taught when pupils are ready. Generalizations stress pupils learning vital broad ideas as subject matter. The following is an example of a generalization which becomes an objective at the appropriate time in mathematics instruction: Radius squared times pi times height is the formula for finding the volume of a cylinder. Abstract knowledge is preferable to the concrete and the semiconcrete when the philosophy of a subject centered mathematics curriculum is being emphasized. However, to learn subject matter, a pupil may need objects, items, and realia (concrete materials) to learn the abstract. Illustrations (semiconcrete materials) of what is being learned might also assist the pupil to learn more rapidly in terms of achieving the abstract. Thus actual models and illustrations of cylinders may help pupils to learn more rapidly and meaningfully that "radius squared times pi times height is the formula for finding the volume of a cylinder." In a subject centered mathematics curriculum, skills objectives for pupils to attain are also vital. Skills objectives and their implementation assist pupils to learn subject matter more readily. Skills objectives include critical thinking in ongoing lessons and units of study. Critical thought emphasizes that pupils separate fact from opinion, fantasy from reality, and accurate from inaccurate information. Mathematics as subject matter stresses accuracy in terms of what is a correct answer as compared to what is incorrect. Pupils need guidance and good teaching so that pupils make the distinction of fact from opinion, fantasy from reality, and accurate from inaccurate ideas in mathematics.

The subject centered mathematics curriculum has its merits. Certainly, everyone should be for pupils learning more vital content in mathematics. Generally a subject centered approach in learning deemphasizes the use of concrete and semiconcrete materials of instruction. With concrete materials which relate directly to what is being taught will extend meanings and understandings of learners. Thus if pupils are learning to add unit fractions, they should have the one-half and one-fourth of a circle or square directly in from of them. These models can be shown when combined to equal three fourths of the circle or square. Pupils may then see the model circle and square with the one-fourth and one-half combined to equal three fourths. The abstract fractions may be written next to the models, such as 1/2 + 1/4=3/4. One half may be shown to equal two fourths by placing two fourths over the one-half in a model circle/square. Pupils may then realize that the fractional part of the circle/square being considered in fourths which is the denominator whereas the number of parts being considered is one plus two fourths or three/fourths. Manipulative materials need to be used in teaching so that a hands on approach in learning mathematics might well be in evidence. Learners should hold and manipulate the models. They should also do the writing on the chalkboard or overhead to show the fractional values of 1/2+1/4=3/4. Too frequently, a subject centered mathematics curriculum deemphasizes learner involvement. And yet, the focal point in teaching is the learner. The pupil needs to do the learning whereas the teacher sets the stage so that pupils may achieve, grow, and develop. The interests and attention need to be obtained of learners in a caring environment. Very often, the basal textbook is the major means of instruction in a subject centered mathematics curriculum. The basal text is neither good nor bad, but neutral depending upon how it is used and if pupils are achieving vital objectives in mathematics. The teacher may use concrete and semiconcrete materials to supplement the learning opportunities emphasized in the basal. When subject matter is learned for its own sake, the level of application or applying what has been learned is minimized. Ample opportunities need to be provided pupils whereby they may use subject matter learned in practical situations. When knowledge is used, it will tend to be remembered better and recalling what has been learned will be facilitated.

Philosophy of Experimentalism

The philosophy of experimentalism takes out many of the weakness of a subject centered procedure in teaching mathematics. Here, within a contextual situation in teaching mathematics, pupils select a problem to solve. The problem is realistic and perplexities exist in how it is to be solved. Pupils individually or collaboratively may work on a problem to be solved in mathematics. Notice, there are perplexities or difficulties involved in how to solve the problem and what the hypothesis should be in answer to the problematic situation. Problem solving does not emphasize rote learning or drill and practice from a workbook exercise (Ediger, 1997).

For example, a pupil or pupils may ask in context, "How does one find the number of square yards of carpet needed for our classroom since it will be recarpeted during vacation time?" This is a good time to emphasize finding the area of square yards or feet in a classroom where practicality is involved. The problem needs to be clearly stated so that pupils know what is wanted in the problem. Vagueness needs to be eliminated. Pupils with teacher assistance then need to discuss possible ways of determining the answer. The mathematics teacher could immediately state the formula for finding the area of the classroom in square units and show on the chalkboard how the computation is done. However, telling is not teaching nor is it problem solving. Pupils need to state the problem and clarify its meaning. The teacher assists, guides, and helps pupils in problem solving. This is a complex role for the teacher. It is much easier for the teacher to jump in and show deductively how the problem is to be solved with pupils following the model presented by the teacher. But, it is the <u>pupil</u> who needs to learn how to identify and solve problems. Thus, after the problem has been clearly identified by pupils with teacher guidance, plans need to be developed to solve the problem. The plans may involve pupils looking for patterns, using models, dramatizing the important ideas, drawing a related illustration looking for diverse possibilities, developing a graph or table, and analyzing the component parts.The plans should be understood by the learner. Vagueness needs to be taken out as much as possible as the work on the problem continues. At the beginning as the problem is being identified, there will be perplexities and that is what problem solving is all about. The perplexities then need to be cleared up as the learning activity progresses. Within the data finding involving planning, an hypothesis or tentative answer follows. Learners need to understand that an hypothesis is tentative and not an absolute. The hypothesis needs to be tested in a lifelike situation. Thus, the hypothesis may be revised, if need be. The hypothesis may also have been correct in its original statement in determining the area of the classroom in square yards or feet.

Mathematics for pupils should be purposeful, meaningful, useful, sequential, and interesting (Ediger, 1998). Experimentalism, as a philosophy of education appears to meet many of these criteria. Thus, in finding the area of the classroom, carpeting would soon be placed therein. A purpose was then involved for learning and that purpose was to find the number of square feet/yards in the classroom. Meaning was emphasized when pupils, with teacher guidance, understood what was involved when computing the area of the classroom. Subject matter learned was useful in that a practical situation was involved whereby carpeting would be installed in the classroom. Pupils with teacher assistance largely did their own sequencing by using flexible steps of problem solving. The effort put forth in solving problems chosen by pupils appears to emphasize the interest factor in learning mathematics.

Philosophy of Decision Making

Experimentalism, as discussed above, does involve the many decisions that need to be made by pupils in problem solving. In contrast, a decision making philosophy also emphasizes pupils choosing from among alternatives to pursue in objectives learning opportunities, and appraisal procedures. The decisions and choices may be made individually or within committees. The learner is the chooser and needs to learn to accept responsibilities for choices made. Problem solving activities as well as other kinds of experiences may be chosen by the involved pupil. With pupil choice, purpose and reasons for making the sequential selections might well be in the offing. Pupil purpose in making choices should increase energy levels for learning. Thus, a pupil may omit that which is not perceived as being purposeful. There are an adequate number of learning opportunities to choose from to keep a pupil learning sequentially and be on task. Sequence resides within the pupil, not in the teacher nor the basal textbook.

The mathematics teacher needs to be a good organizer in having pupils engage in decision making in the curriculum. A learning centers approach might well be used here. The following learning centers may be developed by the teacher or through teacher/pupil planning, for a unit on <u>Geometry for Primary Grade Pupils</u>:

1. An art center. Here, pupils may develop an art project from diverse cutouts of geometrical figures. This may be a good way for pupils to identify squares, rectangles, circles, trapezoids, parallelograms, and triangles. The art projects, after completion, should be displayed in the classroom or hallway near to the classroom door.

2. A model making center. Here, pupils individually or in a small group may make models of geometrical figures with each labeled properly. The models should be displayed above the chalkboard for pupils to refer to, as needed, when they pursue ongoing lessons in geometry.

3. A work sheet center whereby pupils learn to determine the perimeter of selected geometrical figures presented in picture form. Formulas for determining perimeter may be written clearly on a chart for future reference. The pupils at this center may wish to work collaboratively to determine perimeters. The resulting learnings should be applied to the real world of concrete and semiconcrete materials.

4. A dramatization center. Here, pupils may engage in planning for and dramatizing a play pertaining to geometrical figures. Much creativity is necessary in order to role play a specific geometrical figure such as a square. The others in the classroom may observe the play after its completion and rehearsal.

5. A textbook center. Here, pupils individually or collectively may work selected exercises from the basal. The exercises relate directly to the ongoing unit being studied. Pupils may help each other as necessary or the teacher may provide needed guidance.

6. a drawing center. Here, pupils may develop diagrams that explain partially what is being learned. Thus, to find the area of a triangle, pupils may develop two triangles from a square to realize and understand the formula: 1/2 base times height, or 1/2 bh.

7. An audiovisual center. Pupils may observe a videotape and answer questions at the center related to its contents,

8. A computer center. Here, pupils may work on drill and practice, tutorial, simulation, and games for review purposes as well as to obtain new subject matter pertaining to the unit being pursued.

9. A writing of problems center. Pupils may write problems for others to solve related to the lesson or unit being pursued.

10. A reading center. Pupils may select and read a library book of

their own choosing pertaining to mathematics. These books need to be on diverse reading levels and topics in mathematics.

Pupils need to choose the centers they wish to work on sequentially. If decision making is to be involved, then more tasks need to be available than what a pupil can complete. Tasks that lack perceived purpose may be omitted. If pupils are not on task, the teacher needs to assist these pupils to get back on task. Being at learning centers and completing tasks therein is demanding, not a goof of. The teacher monitors pupil work so that high quality products and processes are in evidence. The pupil is the chooser of which center and tasks to work on. If too many pupils select the same center to work at, the teacher needs to be a good organizer so that pupils are spread out at the different centers. A rotation basis may also be used whereby pupils rotate in working at a center, but still choose what to learn and what to omit. The goal is to have pupils achieve mathematics content and skills more optimally since tasks may be chosen that represent pupil purpose. Decision making is also stressed.

Measurement Driven Philosophy

There are many advocates of measurement driven instruction in mathematics. Highly precise objectives need to be chosen by the teacher, district, or on the state level as mandated objectives. The state level then mandates of requires pupils to take tests to determine how well they are doing in achieving the highly precise objectives of instruction.There is no pupil input into the determination and writing of these objectives. The teacher chooses the learning opportunities which assist pupils to achieve these objectives. Criterion referenced tests (CRTs) are given periodically to pupils to ascertain how much achievement there is on the part of pupils in achieving the stated objectives. Schools within a district or school districts may be compared in test results to notice which schools stress stronger achievement than do others. These comparisons might be very unfair since pupils grow up in different kinds of homes with some providing more educational advantages due to having more income. Money does buy many advantages in life. With more educational advantages for some as compared to others, it is no wonder that mathematics achievement is higher or lower for some pupils as compared to others.

Which basic beliefs are in evidence with measurement driven instruction (MDI)?

1. All pupils experience the same mathematics curriculum, but individuals may work at achieving these objectives at different rates of

speed.

2. Sequence in learning with the chosen learning opportunities is determined by the mathematics teacher.

3. The objectives are selected externally in relationship to the pupils in the classroom. Thus, pupil input tends to be omitted in the mathematics curriculum.

4. Being able to measure pupil achievement receives major emphasis since results are stated in numerical terms such as percentiles, grade equivalents, standard deviations, quartile deviations, and stanines.

5. Reporting pupil progress in mathematics to parents is much easier if numbers can be used, as indicators, to show learner achievement.

MDI may stress, too frequently, measurement of facts that pupils have learned since these are easiest to measure in achievement. Higher cognitive objectives and their accomplishment are much more difficult to measure.

Ediger (1995) summarizes the MDI philosophy of instruction with the following statements:

1. precise, measurably stated objectives are written prior to instruction.
2. the teacher may announce prior to teaching what students are to learn as a result of instruction.
3. activities for instruction should contain only that which is stated in the objective.
4. appraisal procedures emphasize evaluating student achievement in terms of what was stated in the objective.
5. sequence of activities provided for students is planned by the teacher.
6. tests are valid if they measure what is stated in the objective.
7. activities are valid if they align directly with the stated objectives.
8. techniques of appraisal need to align very precisely with the objectives.

Adult Determined Mathematics Curriculum

There are numerous adult centered mathematics curriculum plans of instruction. MDI emphasizes adults, highly capable in mathematics, determining which objectives pupils are to achieve. I would like to discuss another adult determined mathematics curriculum plan. Standards setting has become very important in curriculum development. These standards may not be stated in measurable terms, but represent established goals by adults who are very competent in mathematics. "High expectations" has become a key word here. The feeling is that if teachers have high expectations for pupils in mathematics, the latter will achieve at a higher level. The stated goals in themselves reflect the thinking that pupils can achieve that which is much more challenging than what is presently emphasized in the classroom. Thus, setting goals at a higher level of complexity as well as higher teacher expectations for pupil in mathematics will guide the latter to achieve at a more optimal level. The National Council Teachers of Mathematics (NCTM, 1989) developed an excellent set of objectives for pupils to achieve; the following is an example of Communication, Reasoning, and Connections Standards (p.26):

Kindergarten through Grade Four

Standard 2: Mathematics as Communication. In grades K-4, the study of mathematics should include numerous opportunities for communication so that students can:

* relate physical materials, pictures, and diagrams to mathematical ideas:
* reflect on and clarify their thinking about mathematical ideas and situations:
* relate their everyday language to mathematical language and symbols:
* realize that representing, discussing, reading, writing, and listening to mathematics are a vital part of learning and using mathematics.

Standard 3: Mathematics as Reasoning. In grades K-4, the study of mathematics should emphasize reasoning so that students can:

* draw logical conclusions about mathematics:
* use models known as facts, properties, and relationships to explain their thinking...

Standard 4: Mathematical Connections. In grades K-4, the study of mathematics should include opportunities to make connections so that students can:

* link conceptual and procedural knowledge:
* relate various representations of concepts and procedures to one another:
* relate various representations among different topics in mathematics:
* use mathematics in other curriculum areas:
* use mathematics in their daily lives.

The above named standards indicate the need for pupils to relate, reflect upon, use, as well as integrate the four vocabularies of listening, speaking, reading, and writing in the curriculum area of mathematics. Logic needs to be stressed heavily in that pupils need to to be able to draw conclusions, use models and patterns, justify answers and solution processes, as well as experience mathematics as a meaningful curriculum area. In linking mathematics to other curriculum areas as well as to their daily lives, pupils make connections indeed!

The above example indicates what an adult determined mathematics curriculum has to offer teachers in terms of voluntary standards to emphasize in the classroom. I believe strongly that objectives developed by groups and organizations outside the local classroom and this includes objectives developed on the state level should be voluntary to stress in the classroom. I believe strongly that mathematics teachers should be well grounded in the NCTM standards through workshops, faculty meetings, and other means of inservice education. In this way, mathematics teachers have vital goals to select from to improve the curriculum. Much time and effort went into developing these standards for teachers to emphasize in the mathematics curriculum. The teacher might then select and adapt those relevant objectives for pupils to achieve whereby readiness, purpose, and interest in learning is in evidence. Learning opportunities need to be chosen by the mathematics teacher to help pupils achieve these goals (Ediger, 1996).

Conclusion

There are diverse philosophies which teachers and administrators need to consider and appraise. The philosophy or philosophies chosen in instruction need to harmonize with pupils' individual learning styles. Learners need quality objectives, learning opportunities, and evaluation procedures to achieve as optimally as possible in mathematics. There may be times whereby a more openended as compared to a highly structures mathematics curriculum needs to be emphasized. At other times, pupils may need a more structured environment in mathematics. The pupil is the focal point of instruction in mathematics. Mathematics is a basic and it is vital for pupils to learn as much as possible therein. Teachers and administrators need to stay abreast of current trends in the teaching of mathematics and implement what is relevant and assists pupils to learn as optimally as possible (Ediger, 1998).

References

Ediger, Marlow (1995), Philosophy in Curriculum Development. Kirksville, Missouri: Simpson Publishing Company, 21.

Ediger, Marlow (1997), Teaching Mathematics in the Elementary School. Kirksville, Missouri: Simpson Publishing Company, 46-48.

Ediger, Marlow (1996), Essays in School Administration. Kirksville, Missouri: Simpson Publishing company, 1-4.

Ediger, Marlow (1998), "Mathematics for the Urban Student," The Philippine Education Quarterly, 26 (4), 76.

Ediger, Marlow (1998), "Change and the School Administrator, Education, 118 (4),541-548.

National Council Teachers of Mathematics (1989), Curriculum and Evaluation Standards for School Mathematics. Reston, Virginia: NCTM, 26.

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